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ABSTRACT

The purpose of this study was to determine the effectiveness of errorless discrimination training in teaching young retarded children to pair a given letter symbol with a specific sound. A secondary objective was to determine the extent to which the letter-sound discrimination would generalize to the skill areas of omitting the desired sound when shown the letter, and of constructing the letter when the appropriate sound was presented. Subjects were 4 mentally retarded males in primary and intermediate special aid classes who were chosen because of their lack of knowledge of the sounds of letters. Subjects performed on teaching machines for 15 minutes on each of 14 consecutive school days. Each subject was alternately exposed to each of two stimulus methods. Each method provided discrimination training of letter sounds and symbols for 13 of the 26 letters in the alphabet. Pre- and post-test data showed that errorless form discrimination training was as effective as customary trial-and-error discrimination training in producing gains. However, the errorless method differed in respect to daily performance, for it generally resulted in a higher percentage of correct responses made in less time than did the trial-and-error method. The letter-sound associations which were mastered did not often generalize to related verbal skills. (Author/DR)

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PROGRAMMED INSTRUCTION AS A MEANS OF ESTABLISHING "ERRORLESS" LEARNING WITH KINDERGARTEN LEVEL CHILDREN

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CHAPTER I

INTRODUCTION

Discrimination training is a fundamental and pervasive aspect of education. The objective in discrimination training is to bring the learner's behavior under the control of a stimulus. The usual procedure in establishing a discrimination is to reinforce the desired response when it is made in the presence of a given stimulus, and extinguish other responses made to that stimulus. As an example of traditional discrimination training, assume a child is being trained to identify colors, and that the teacher has placed the three colors red, green, and blue in front of him. The teacher asks the child to point to the "red" color. The behavior emitted by the naive child in selecting the appropriate color is customarily labeled "trial and error" learning, for the probability of the child pointing to one of the two wrong choices is twice as great as the probability of his pointing to the red color. This type of discrimination training has great import for education, especially since it is the basis for the multiple-choice materials which are so prevalent in the United States.

A major criticism leveled at the multiple-choice, trial and error method of establishing a discrimination is that it allows the students to

make errors. Recent research findings (Terrace, 1963; Moore and Goldiamond, 1964; Sidman and Stoddard, 1967; Gollin and Savoy, 1968; and Touchette, 1968) provide evidence that errors are not essential to establish a discrimination. They further suggest that the elimination of errors is a more efficacious way to establish a discrimination than that obtained through the typical trial and error process which makes no provision for minimizing or reducing errors.

The purpose of this study was to determine the effectiveness of errorless discrimination training in teaching young retarded children to pair a given letter symbol with a specific sound. This type of discrimination training, customarily labeled "phonics," consisted primarily in putting the child's behavior of selecting a letter under the control of the appropriate auditory stimulus. Thus, in the presence of the auditory stimulus "a," as in "cat," the probability of a child selecting the letter "a" from a variety of choices was kept as close as possible to 1.00. The effectiveness of the errorless discrimination training was determined by comparing it with the customary discrimination training technique which makes no provision for minimizing errors.

Discrimination training, whether errorless or trial and error, is capable of establishing only a minimal repertoire, and can therefore be considered merely propaeduetic to development of a more complete repertoire. Illustrative of this contrast between a minimal and a more complete functional repertoire is observed when a child is learning the

multiplication combinations. After a relatively short period of discrimination training, the child readily makes the appropriate response to the following choices: 6x6 = 16 6x6 = 36 6x6 = 12. If after a short interval of time, the child is asked to give the product of 6x6, the probability is great that he will not say "36." Yet it is obvious that the completion item is the type that the child must master, for this is the behavior he must emit in his daily encounters with classroom mathematics problems.

In the same way, the child may first acquire a notion of a letter and its corresponding sound through discrimination training. By itself, the ability to discriminate has little functional value in reading; the main skills a child needs in applying phonetics are: (1) to be able to emit the desired sound when shown the letter, and (2) to be able to construct the letter in the presence of the appropriate sound.

Evans (1961) reported that young children who had received discrimination training with letter forms showed improvement in their ability to construct letters. A secondary objective of the present study was to determine the extent to which the letter-sound discrimination would generalize to the two areas identified immediately above.

CHAPTER II

RELATED RESEARCH

Errorless Acquisition of a Discrimination

Recent studies by Terrace (1963) have provided an effective method for establishing a discrimination in the absence of "errors." The distinctive aspects of Terrace's method might be made clear by contrasting it with the conventional methods used in discrimination training. In this latter method, there are two distinct and contrasting conditions, usually a light on condition (S^+) and a light off condition (S^-). During the light on (S^+) condition, a specified response, e.g., a lever press, is followed by a reinforcer, such as food. During the light off (S^-) condition, extinction is used, and the animal is never reinforced for a lever press. Through continued alternation of reinforcement and extinction, a discrimination is eventually established. It should be added that extinction generates aversive side effects; emotional behavior is a readily observed concomitant of extinction. An impressive feature of the above training is the large role extinction plays; it occupies the great majority of the animal's time and behavior. It is during the extinction interval that the animal is most active. By contrast, the S^+ interval is relatively short; and usually only one response is allowed to occur and be reinforced.

The "errorless" method developed by Terrace emphasizes the S + condition, for it is only during that interval that the animal is reinforced. But Terrace was aware that "it is impossible to establish a discrimination by simply reinforcing responding to S +." (1968, p. 469). There must be alternate exposures to S + and S—.

Terrace's methods in training pigeons to discriminate between a red (S+) and green (S—) disk illustrate his technique for establishing errorless learning. Initially the red disk (S+) is illuminated and the green disk (S—) kept dark. The pigeon pecks the red disk several times and is reinforced. There are occasional intervals of non-pecking; and when they occur, the disk is darkened (S —). Initially there is a disparity in time intervals, with S+ being much longer than S—. With each alternate presentation of the S + and S— conditions, the time intervals are brought closer together in length. Eventually the discrimination is established; the pigeon pecks the disk when it is red, but does not peck the darkened disk regardless of how long it is presented.

The next step requires slowly increasing the brightness of the green disk. Initially the green disk is faint, but with each alternation of red and green disks, the green disk becomes brighter. At the terminal stages of training, the red and green disks are equally bright, but the pigeon is pecking the disk only in the presence of the red light. No errors occurred during the training, and none occurred when the equally bright green and red disks were alternately presented.

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Touchette (1968) used a graduated stimulus change, i.e., fading, technique to establish a discrimination with seven severely retarded subjects who had given evidence of being incapable of learning a discrimination. The subjects' discriminative task was to press one of two windows, depending on which of the two windows was closest to a small, black square. In the graduated stimulus, or errorless, method, the subjects were presented with extremely gross discriminations in which the probability of a correct response was quite high, i.e., close to 1.00. With each trial, the initially gross discrimination was altered; so that on the final trials, the subject was presented with the criterion discrimination. All six subjects mastered the discrimination and made few or no errors. A second group of seven subjects was given trial and error training in which only the criterion discrimination task was shown. Six of those subjects failed to learn the task; their behavior throughout was the same as chance.

Along with demonstrating the efficacy of errorless discrimination training in which the discriminative task was gradually altered, but never so rapidly as to minimize the probability of a correct response, Touchette's findings suggest that ". . . a history of trial and error training may interfere with acquisition and retention of a discrimination." (Touchette, 1968, p. 46)

Gollin and Savoy (1968) assessed the abilities of young children (37 to 107 months) to master a subsequent discrimination task following an initial period of discrimination training. One group learned the

initial discrimination through a traditional, i.e., trial-and-error, process. A second group learned through a fading, i.e., errorless, process in which two initially disparate stimuli were brought closer together in brightness until the terminal discriminations were the same as those which existed throughout the trial-and-error condition. The results of the training on the first discrimination task showed that the fading process generated a greater number of errorless performances than were obtained through the traditional trial-and-error process.

The final discrimination task required subjects to select the stimuli that were the correct choices on the initial discriminative task. There were two such stimuli and they were presented in a random order. The writers indicated that the final discriminative task provided a measure of which of the two training methods, i.e., errorless and trial-and-error, would most facilitate transfer. On the final discriminative task the trial-and-error group made significantly fewer errors than the group which received the graduated stimulus (fading) training. The writers concluded that this latter group did not have equal exposure to the S+ and S− stimuli, thus depriving those subjects of "sufficient comparative experience necessary to permit efficient transfer." (Gollin and Savoy, 1968, p. 450)

Moore and Goldiamond (1964) used a matching-to-sample technique to assess the effectiveness of a fading technique in teaching discriminations. The sample was a triangle which was presented in a fully lighted window. When a switch was activated, the sample

disappeared and three choices came into view. The subjects' task was to select from the three choices that geometric form which was the same as the one in the sample. In the fading technique, the window containing the correct response was brighter than the windows containing the two incorrect choices. Gradually, the disparity in brightness was eliminated through fading until all windows were of equal brightness. Subjects exposed to these gradually altered choices made few or no errors in learning the discrimination. In the other technique, the windows were kept at equal brightness. The performance of these subjects, who received no cue, was the same as chance. The above results indicate that errorless learning can be established in matching-to-sample procedures.

Mental Retardation

Persons interested in retarded children will want to know the relevance of this study to the education of retarded children. The immediate purpose is to compare the relative efficiency of two methods of teaching sounds of letters in the alphabet to four young, educable mentally retarded children; a longitudinal goal would be to contribute to the development of an efficient and effective method which would teach retarded children to combine individual sounds, enabling them to construct and also to read words.

Reading is the pivotal academic tool for all school-aged children; failure in learning to read contributes to failure in other school subjects.

Retarded children must have at least an elementary ability to read in order to avoid difficulties in arithmetic, communication, personal and social development, and vocational performance. However, inability to learn the many complex skills involved in reading prevents many retarded children from becoming minimally competent readers.

Reading: Skills and Objectives

Complex skills involved in reading include:

> Adequate reception, discrimination among sounds and symbols, association among various components involved in reading, remembering a visual and auditory sequence, understanding material, applying facts and concepts to earlier learned material, and the effective expression of ideas. (Smith, 1968, p. 128)

When we consider the complexities involved in reading, we easily understand why retarded children, with their numerous learning deficits, struggle and become frustrated while learning to read.

The principal objectives of a reading program designed to teach retarded children are similar to those appropriate for children of normal intelligence. Smith (1968) lists the objectives for teaching retarded children to read as:

1. Development of a basic sight vocabulary with elaboration on the existing speaking and listening vocabulary

2. Development of a consistent method for word attack which is appropriate for each child and based on his idiosyncratic strengths and weaknesses

3. Development of skill in and a desire to read independently for information, pleasure, and personal satisfaction

4. Development of an adequate level of reading competence to allow for effective social and vocational participation in society (Smith, 1968, p. 130)

Although the objectives in reading are basically the same for all educable mentally retarded (EMR) children, the approach the teacher uses, and the degree to which the objectives can be realized will vary for each child.

Approaches to Reading

Teachers of retarded children have traditionally used an eclectic approach in teaching reading. They select, on the basis of their judgment of a child's needs and abilities, an approach they consider to be most beneficial for a particular child. The approaches from which they choose are generally those used by teachers of intellectually normal children, such as: experience, sight vocabulary, phonetic, and multisensory approaches.

Kirk and Johnson (1951) describe a reading program for retarded children which integrates several of these approaches. At the readiness level, they suggest providing the children with a variety of experiences and activities in order to facilitate maturation. During the initial stages of reading, the child learns to read short sentences about his experiences by using memory and recognition of the configuration of the sentences. As he progresses in ability to discriminate individual words in the sentences, his sight vocabulary begins to develop. It is not until the child has acquired a sight vocabulary of approximately 150 words and had initial success in reading primers that he begins to

learn word recognition skills of phonetic and structural analysis. Later, oral reading and comprehension are stressed. In a recent article, Strang (1965) discusses a similar approach, so it is apparent that some educators continue to use an eclectic approach.

Teachers of retarded children often depend upon a workbook approach to develop reading skills. This may seem to be the only solution to teaching reading when every child in the special class is performing at a different level. In addition, teachers might use techniques of a multisensory approach incidentally when introducing their students to letters and words. McCarthy and Oliver (1965) review the following tactile-kinesthetic techniques: arranging, tracing, cutting, and pasting letters; making and feeling letters made of felt, sandpaper, or clay; and writing letters in pans of salt or wet sand. These techniques reportedly stimulate the senses and aid in concentration on the task.

Sheperd (1967) has found, in comparing groups of adequate and inadequate readers among mentally retarded boys, that inadequate readers lack word attack skills. They are especially weak in phonetic skills and in use of contextual aids. Studies such as this should encourage special educators to reexamine the emphasis on and sequential position of phonetic skills in the total reading program. Brown (1967) has studied a remedial, phonic-based program which provides a simultaneous presentation of visual and auditory material. His results in work with adolescent slow-readers indicate large gains in reading attainment.

Teachers of EMR children should not be criticized for using

an eclectic, necessarily "watered-down" version of the reading program planned for intellectually normal children; for there have been few "special" reading books or programs developed for use with retarded children. However, new methods and materials of reading instruction are currently being developed which offer great promise for teaching EMR children to read (McCarthy and Scheerenburger, 1965).

The Initial Teaching Alphabet (ITA), assessed by Williams (1965), may offer an easier approach to beginning reading for retardates than have traditional methods. Williams suggests cautious optimism regarding use of the ITA, for results of studies investigating the retarded child's ability to transfer to the traditional alphabet have not been conclusive.

Reading readiness workbooks designed for children with specific learning difficulties are now available. Goldstein and Levitt (1968) have developed a readiness kit with accompanying workbooks planned to introduce the four cognitive areas of visual discrimination, auditory discrimination, spatial discrimination, and concepts relevant to beginning reading.

Programmed Instruction

One of the most promising approaches to education today is that of programmed instruction (PI), in which a carefully prepared sequence of content material is presented in small, appropriate steps. PI, applicable to all aspects of the academic curriculum, is available to an individual learner in the form of programmed textbooks or teaching machines.

Although PI cannot be considered a panacea for the problems in educating the retarded, it has been found effective in teaching basic academic skills to EMR children. Reviews of research on PI with retarded children are prevalent in the literature since 1960 (Malpass, 1967; Watson, 1966; and Johnson, 1968).

The four major principles of PI are (1) small steps, (2) active responding, (3) immediate confirmation, and (4) self-pacing (Malpass, 1967). The advantages inherent in an approach which embodies these principles are impressive to informed special educators. The retarded child responds, at his own rate, to material which is at his particular ability level and has immediate knowledge of results. The sequential steps in difficulty are planned to provide adequate repetition and near errorless learning. PI makes the popular goal of individualized instruction a future reality.

Planning a good program is difficult and time-consuming. The programmer must design the material in such a way that it leads to a predetermined goal, is easily understood by the learner, provides adequate repetition and logically-related successive steps, and excludes unnecessary or distracting material (Malpass, 1967).

In a recent study (Bijou, Birnbrauer, Kidder, and Tague, 1966), PI materials were used throughout each day for several years in an experimental classroom for EMR children. Study behaviors were shaped and reinforced, and then PI materials were used to teach the primary academic subjects. Each child had his own schedule of tasks and

activities to successfully complete in order to receive his tokens each day. Results indicate that the children worked faster, accomplished more, and experienced at least as much success as they had in previous school settings.

Much has been done to plan commercial PI machine materials for EMR children, but Johnson (1968) advises that more of our emphasis on program development should be directed towards exploring the possibilities of new teaching methods which are not found at the safe, conservative commercial center of PI.

The study discussed in this thesis was planned to be an exploration of an experimental PI method for teaching letter-sound associations to young EMR children. Silberman (1965) has written a review of PI of reading and related verbal training in which he discusses the problems of sequencing materials in order of increasing difficulty. Three of the dimensions of sequencing he discusses are relevant to the rationale and organization of the experimental method found in this study.

The factor of Gradual Progression is based on evidence which suggests that, "learning a difficult discrimination is easier if it is preceded by training on a similar but easier discrimination." (Silberman, 1965, p. 509) The Form Discrimination (FD) method of learning to associate letters and their sounds described in this paper provides a gradual progression from easy discriminations to more difficult ones.

Analytic vs. Synthetic Sequences are concerned with whether reading instruction should be directed toward finding parts in wholes, i.e.,

learning words and phrases first, or toward building wholes out of parts, i.e., learning phonics skills first. Advocates of the analytic approach are usually much opposed to phonetic training for beginning readers, arguing that such training will be meaningless and difficult. Silberman (1965) states that for synthetic or phonic approaches, elements should be programmed in the form of a letter or group of letters. Both experimental methods described in this study are phonic approaches. The traditional trial-and-error (TE) method presents three different letters for each item, while the FD method presents three different forms of a single letter per item.

The factor of Stimulus Similarity provides a rationale for preference of the form discrimination method. Silberman (1965, p. 518) says "In a program in which the stimulus words are quite similar and where difficult discriminations must be made, errors of generalization are more likely, and learning difficulty will increase." If the factor of Stimulus Similarity is controlled by maximizing the initial disparity of the stimuli, some provision must be made for progressively requiring finer discriminations so that the learner will be able to make the fine discriminations necessary in reading. The FD method begins with stimuli which require gross discriminations and then successively approximates finer discriminations as the stimuli become more similar.

CHAPTER III

METHOD

Subjects

Four educable mentally retarded males were selected from children enrolled in primary and intermediate special aid classes at the Illinois State University Laboratory School, Normal, Illinois.

Fourteen of the 24 potential subjects were eliminated on the basis of their knowledge of sounds evidenced by reading achievement. Two were excluded because of their participation in previous experiments similar in nature. The eight remaining children were administered a battery of pretest items and the four chosen for the study demonstrated that they had almost no knowledge of the sounds of letters.

The three tests in the pretest battery were: Test 1, which required S to construct a letter on paper when its sound was given; Test 2, which required S to make the sound of a letter when the letter was presented visually; and Test 3, for which S listened to the sound of a letter and pointed to it on a multiple choice item card showing three different letters as choices. It was possible to score a maximum of 26 points on each of the three tests, for every letter of the alphabet appeared once as an item on each test.

Tests 1 and 2 required types of responding which were not presented as tasks during the experimental treatment. However, it was felt

TABLE 1

INFORMATION ON SUBJECTS

Subject	CA	Most Recent IQ Score[a]	Distance Visual Acuity	Pretest Scores
A	8-5	68	RE 20/40 LE 20/40 (with glasses)	1. 1/7 2. 0/15 3. 3/13
B	11-6	70	RE 20/20 LE 20/20-1	1. 0/13 2. 0/26 3. 9/26
C	8-1	75	RE 20/20 LE 20/20-1	1. 0/6 2. 1/14 3. 6/13
D	10-2	36	RE 20/20 LE 20/20-1	1. 0/3 2. 0/26 3. 5/13

[a]All IQ scores Binet (L-M) except Subject D, Slosson.

that any changes in responses on these tests from pre-to posttest could have meaningful implications. Items on Test 3 were most similar to items in the daily programs.

The administration of the pretest made use of a Uher 2000-L Portable Tape Recorder. E recorded the sounds of the letters in the alphabet in random order for use in Tests 1 and 3. Vowels were recorded in their short sound form; consonants were recorded as they would sound in an initial position in a word, followed by a schwa sound when necessary (as for "b"). Each S's sound responses for Test 2 were

recorded so that they could be evaluated by other observers.

An audiologist screened all subjects at a level of 10 dB (ISO) using a pure tone audiometer in a sound-treated room. He also administered the Phonetically Balanced Kindergarten Word List which is designed to measure word discrimination ability. On both tests all subjects (Ss) fell within normal limits, indicating that their auditory skills would not detract from their ability to perform in this study.

The writer was unable to identify a test of visual discrimination suitable for the purposes of this study; therefore, visual discrimination items deemed relevant to success on the daily programs were adapted, composed, and combined to make a test of visual discrimination. Samples of items which appeared on this measure and a record of Ss' choices will be found in Appendix A.

Subject A (S-A) lives in an institutional home setting, and is reported to have been rejected and physically abused by his parents when he was very young. It is suggested that S-A was emotionally and educationally deprived while living with his parents, and that he may have had potentially average intelligence.

The results of a Bender-Gestalt indicate poor reproduction of visual patterns and questionable visual and perceptive functions. S-A wears glasses and has had eye surgery for strabismus.

S-A is an attractive, well-dressed boy. Although he is underdeveloped and undersized for his age, he has good gross motor coordination. S-A, a verbal child who has well-developed speech and language

skills, is progressing rapidly through readiness activities in school.

Subject B (S-B) also lives in an institutional home environment. He was reported in June, 1968, to be working at a readiness level in an intermediate class and making poor progress. It is noted that S-B was frustrated with his inability to read, tended to be dependent, and used excuses to dismiss himself from learning situations. It was suggested that he have more emphasis on use of auditory skills.

In January, 1969, S-B was reading at a pre-primer level with some degree of comprehension, working at a first grade level in arithmetic, and was applying some self-control to his behavior. Peer disapproval had effectively reduced most of his immature behavior.

S-B attends speech therapy sessions for a total of 40 minutes weekly. Speech reports indicate that he has multiple articulation errors, distortions, and substitutions; limited vocabulary; and inadequate sentence structure. It is noted that S-B becomes upset when his speech is not understood by others.

Subject C (S-C) is the youngest of three children living with parents who are of average economic status. His school psychological records report a family history of poor physical health and mental retardation. S-C, whose records show a diagnosis of minimal brain dysfunction (1967), was born prematurely by Caesarean section. He is reported to have an asthmatic allergy, poor muscular coordination, delayed speech and general development, and mild mental retardation.

S-C's early school adjustment was poor; he was deficit in important motor and perceptual skills, experienced difficulty with

language development, and did not enjoy social interaction or friends. He was dependent and seemed to possess a minimum of self-confidence. His mother tends to be overprotective, yet demanding.

S-C exhibits a great degree of distractibility in his class at school and, for this reason, his desk is set off from the rest of the group by a folding screen. S-C displays a wide variety of emotional responses and can vascillate quickly from one to the other. His teacher considers his educational prognosis to be poor, for his minor gains at the readiness level seem to lack permanency.

S-C attends speech therapy sessions totaling 40 minutes per week. Speech reports indicate that he has immature articulation and language development as well as inconsistent speech behavior. S-C speaks in a whiney tone of voice and frequently cries when activities are not carried out according to his wishes.

Subject D (S-D) fits the description of a child who has been culturally and educationally deprived. Although records show that he is ten years of age, his physical appearance and bone structure is similar to that of a child of seven years. There is considerable dispute among members of his family as to when S-D was born. He had not attended school until the 1968-1969 school year.

His mother reports that her pregnancy with S-D lasted for 11 months, and that a twin died at birth. S-D weighed three pounds at birth and suffered from malnutrition when nine months old. A high-school aged sister disagrees with some of the above information.

Although S-D's performance on the Slosson Test of Intelligence indicates that he is of trainable intelligence, his behavior and appearance

lead one to judge him as educable as well as question how valid any test with this child could be. His school progress in pre-readiness activities has been good; however, frequent absence from school seems to detract from progress made.

S-D's speech is characterized by multiple articulation errors, substitutions, and omissions of words and phrases; limited vocabulary usage; immature language patterns; and stereotyped verbal responses. S-D attends speech therapy sessions totaling 40 minutes per week. He has a short attention span, is easily distracted, and needs much reassurance and constant encouragement in order to complete a task. It has recently been discovered that he responds well to physical contact and affection. S-D had not been encouraged to speak before coming to school, so he was unable to use verbal skills to communicate and relate with others.

Apparatus

Equipment for the study was contained in two adjacent rooms, 5 x 9 feet each, which were part of a large experimental laboratory. The machines used, the MTA Scholar Teaching Machine 400 and the Behavioral Controls Coin/Token Dispenser, were located in the experimental room, which was sound-restricted and had adequate overhead lighting. S sat on a chair adjusted in height so he could easily see and touch the three visible response windows of the teaching machine in front of him. Directly above the teaching machine as part of the wall, was the mirror side of the one-way observation window. To the S's left, on the same table as the teaching machine, was the token

dispenser from which a light flashed and buzzer sounded whenever a token was released for a correct response. A photograph and description of the teaching machine and token dispenser will be found in Appendix B. The controlling stimuli, sound cues, were provided by a Cousino cartridge-loaded tape player/recorder located to the S's far left. An intercom system unit was placed on the table near the tape player.

The observation room, located adjacent to the experimental room, was equipped with data recording apparatus as well as with the window side of the one-way mirror through which the experimenter (E) could observe each S. An Esterline Angus 10-Event Recorder provided a record of responses made and a measure of time for each item. E observed S throughout each experimental session, recording correct and incorrect responses, order of letter choices, and unusual or characteristic overt behavior. E's recordings also provided a precautionary measure to prevent loss of data should there have been a mechanical failure. All of the equipment was synchronized and functioned independently of E, who remained a recorder in the observation room.

CHAPTER IV

PROCEDURES

General

A schedule was arranged so that Ss arrived at the experimental laboratory at 20 minute intergals. Each S was accompanied by a college student from his classroom to the laboratory. The five minute walk to the laboratory occurred every day for fourteen school days. Following their arrival, Ss were allowed to examine the display of reinforcement items before being taken into the experimental room.

After S was seated correctly before the teaching machine on the first day, he was told to push any one of the three windows on the machine in front of him and then listen for a sound. The program paper advanced to the first item position, showing a response choice below each window, and the tape advanced to emit the first sound cue. The S was then told to push the window which showed a picture of the sound he had heard. For the first two days of the treatment, E stayed in the experimental room for a few minutes to remind S to listen and then push the right window. Through simple directions, E explained to S that when he pushed the right window the first time, a token would fall down from the token dispenser. He could then use his tokens to get money,

candy, or toys. If he didn't push the right window the first time, nothing would happen, but he would need to push the other buttons to find out what the right answer was. After E felt S understood the directions, E left the experimental room. The door of the experimental room was never locked, so S could have terminated the task if he had wished. After the first two days, E made certain that S was seated correctly, told S he could begin, and then left the experimental room.

When S chose the correct response first, the token machine was activated, the next item advanced to the windows, and the appropriate sound cue was emitted. If a child did not make the correct choice first, a correction procedure was used (Sidman and Stoddard, 1967). The choices remained below the windows until the correct response was made. After this took place, the machine did advance to the next item, but no token was dispensed. All choices were automatically recorded by equipment in the observation room. Each child continued responding until he completed the series of choice items on a particular part of the program. This took approximately 15 minutes, depending upon the speed with which the child responded.

When E knew S had completed the day's program, E opened the door of the experimental room, greeted S, and exclaimed over the number of tokens S had earned. S carried his tokens to the table in the laboratory where the reinforcers were displayed. He was praised and helped, if necessary, while he counted his tokens into piles of five. All of the piles were then counted, and S was allowed to choose an item or items

to exchange for his tokens. Different reinforcers cost different amounts. Some cost one pile of tokens, others five piles, and some ten piles. Money and candy were reinforcers at the one and five pile levels, and toys were an addition at the ten pile level. An attempt was made to make available a variety of types of toys and candy. As reinforcers were chosen, new items replaced them, so that there would continually be new items from which to choose. A list of the various reinforcers used at each level can be found in Appendix C.

After S had chosen his reinforcer, he left the experimental laboratory with a college student who accompanied him to his classroom.

Two Stimulus Methods

The consonants of the alphabet were randomly divided and the vowels equally distributed into two lists of 13 letters each, one list for each stimulus method. The method representing the traditional multiple choice technique, as discussed in the Introduction, was termed Trial and Error (TE). The other method, which was designed to reduce the probability of errors through stimulus shaping, was termed Form Discrimination (FD).

Letter choice items from the two methods were the content of the daily programs, and were printed on seven sections of MTA program paper. The two methods were alternated in blocks of three items each; and in each block of three items, the same letter was the correct choice. The controlling stimuli, the letter sound cue for each item, were recorded

TABLE 2

LETTERS IN THE TWO STIMULUS METHODS

Form Discrimination	Multiple Choice	Program Part[a]
b,c,d,f,h,i	a,e,g,j,k,l	1, 2, 3
n,o,s,v,y,z,q	m,p,r,t,u,w,x	4, 5, 6

[a]The learning tasks were divided into seven program parts. All letters appeared on Part 7.

on seven cartridges which were inserted into the Cousino Tape Player. Each printed program paper had a corresponding tape cartridge, and so each letter choice item had one accompanying sound. Sounds were recorded by E at four second intervals, and impulses were recorded on the tape between letter sounds. The impulse stopped the tape following the emission of each sound so that S could respond to the item. The tape was automatically activated following the correct response. Sounds were recorded as they were for the recording used in the pretest: vowels were recorded in their short sound form; and consonants were recorded as they would sound in an initial position in a word, followed by a schwa sound when necessary.

The letters in the TE method were printed in lower-case configuration (Leroy Lettering). Each item contained three letters: the preferred letter and two incorrect choices. For example, if "a" was the

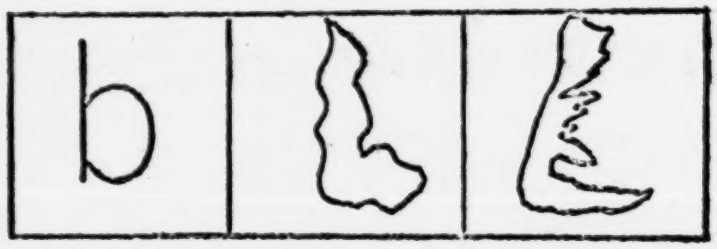
sound presented, the first choice window might present "a," with "k" and "e" as incorrect choices. Incorrect choices were always letters from the TE list. The next two items in the block of three would present "a" and two other letters from the TE list. In each of the three choice items, "a" would be the only correct choice. After three items of the TE method were completed, the next three would be of the FD type.

Letters in the FD method were also presented in lower-case configuration and three-choice format. One configuration was the correct shape of a letter (Leroy Lettering), while the other two configurations initially were grossly out of shape. The wrong configurations were systematically altered each time they appeared so as to become more similar to the correct form. It was S's task to select the correct form of the letter from the three choices shown. (See Figure 1.)

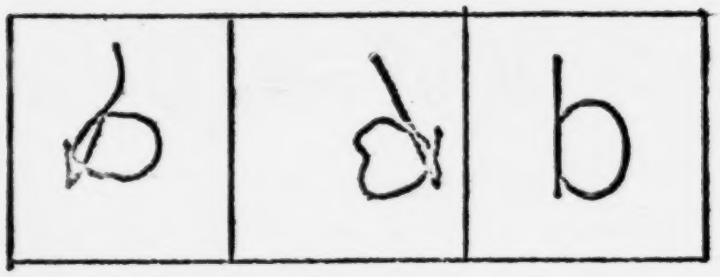
The learning tasks were divided into seven program parts. In Parts 1, 2, and 3, six letters from each method, i.e., TE and FD, were presented (see Table 2). During Parts 1 and 2, the two methods were alternated in blocks of three items each. Part 3 was a review of the 12 letters presented to that point; all FD letters were presented first in random order and were followed by TE items in random order. Parts 4, 5, and 6 corresponded to Parts 1, 2, and 3 respectively, with the exception that the seven remaining letters from each list were presented in this latter part of the program. Part 7 was a test of all letters from both methods in random order.

FIGURE 1

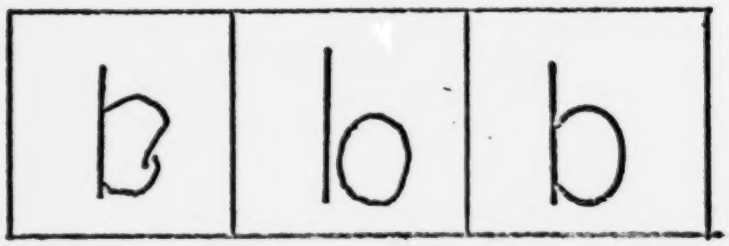
STIMULUS SHAPING: FD METHOD



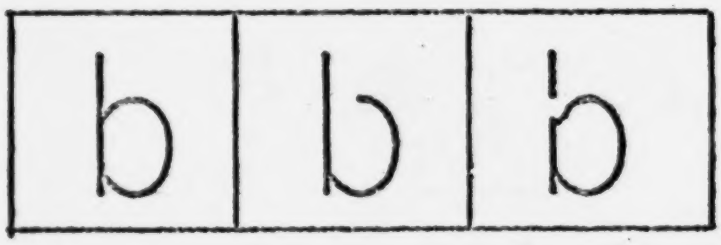
Discrimination Level 2



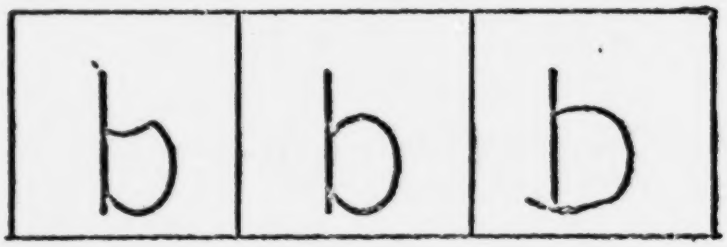
Discrimination Level 4



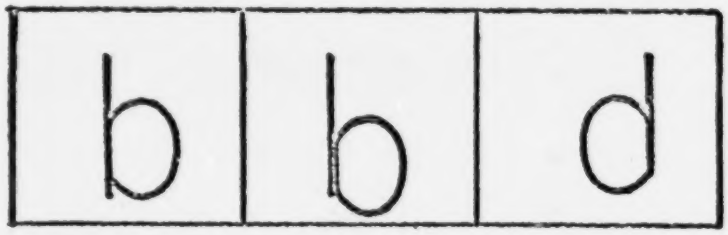
Discrimination Level 6



Discrimination Level 8



Discrimination Level 10



Discrimination Level 12

Each Part contained approximately 37 items from each method, so there were about 74 items to which S responded each day. Ss performed on each Part for two consecutive days to provide repetition; the entire program was completed in 14 days.

CHAPTER V

RESULTS

Pre- and Posttest Data

Three tests were administered at the beginning of the study. The pre-treatment test scores served two purposes: they were the major criteria for selecting Ss; and they provided pretest data of each S's competencies against which posttest measures could be compared.

The three tests which provided pre-and posttest data include: Test 1, which required S to construct a letter on paper when its sound was given; Test 2, which required S to emit the sound of a letter he was shown; and Test 3, a multiple-choice test, which required S to listen to a letter sound and point to the letter on a card which showed the correct letter as well as two other letter choices.

S-A's pre- and posttest data are shown in Table 3. Test 1 shows that S-A gained in his ability to construct a letter after hearing the sound; his gain of seven units is the largest shown by any S on Test 1. The data indicate that he gained one letter more of the FD letters than of the TE letters. The letters in parentheses on Table 3 are the letters for which S-A received credit. It should be noted that the one letter S-A wrote correctly on the pretest, "d," was also written correctly on the posttest.

On Test 2, which measured a S's ability to emit the correct sound after seeing a letter, S-A progressed from zero to five units correct

TABLE 3

PRE-POSTTEST DATA: SUBJECT A

Test		Pretest	Posttest	Difference
1. Construction of Letter	Total	1/7	8/26	7
	FD	1 (d)	5 (d,s,o,b,f)	4
	TE	0	3 (a,t,r)	3
2. Emission of Sound	Total	0/15	5/26	5
	FD	0	4 (d,s,o,f)	4
	TE	0	1 (l)	1
3. Multiple Choice	Total	3/13	24/26	18
	FD	2 (s,v)	12 (d,s,z,o,v,n, h,b,y,i,f,c)	8
	TE	1 (m)	12 (m,e,g,k,a,t, x,l,p,w,r,u)	10

on the pre- and posttest respectively. This gain, the largest shown by any S on Test 2, indicates a differential gain of 4:1 letters correct in the direction of the FD method. The similarity of the FD letters which were scored "correct" in Tests 1 and 2 should be noted; letters "d," "s," "o," and "f" were correct in both instances.

None of the four Ss used in the study was administered every item in each of the pretests, for Ss became distracted and uncooperative soon after failing several items. An adjustment was made for this factor

in the pretest data. For example, S-A pointed to the correct letter on three items of the first 13 of the Test 3 pretest. At this time the test administration was terminated for S-A. It is assumed that had S-A completed Test 3, he could have pointed correctly to six of the 26 items; therefore, he is credited with six units on the pretest results. S-A's gain of 18 units on the posttest is the largest of any S on Test 3, and is in the direction of TE letters, 10:8. Letters scored correct for Tests 1 and 2 also appear as correct units in S-A's Test 3 posttest results.

S-B's pre- and posttest data are shown in Table 4. Test 1 shows that S-B gained six units from a pretest zero in his ability to construct a letter after hearing the sound. The data show a differential gain of 4:2 units in the direction of the TE letters.

S-B gained two units, one each from TE and FD methods, on Test 2, Emission of Sounds. The two sounds he was able to emit correctly represent two of the letters he was able to construct on Test 1. S-B's gain of 11 units from nine to 20 on Test 3, Multiple Choice, shows a differential of 7:4 in the direction of the TE method. Letters scored correct for TE and FD methods appeared as correct units in S-B's Test 1 and 2 posttest results.

S-C's pre- and posttest data are shown in Table 5. Test 1 scores show that S-C did not gain any units in his ability to construct a letter after hearing the sound. However, there is observer agreement that S-C improved in ability to form letter shapes as evidenced by the marks he made on the paper. His Test 1 pretest paper shows one

TABLE 4

PRE-POSTTEST DATA: SUBJECT B

Test		Pretest	Posttest	Difference
1. Construction of Letter	Total	0/13	6/26	6
	FD	0	2 (s,y)	2
	TE	0	4 (a,t,w,p)	4
2. Emission of Sound	Total	0/26	2/26	2
	FD	0	1 (s)	1
	TE	0	1 (a)	1
3. Multiple Choice	Total	9/26	20/26	11
	FD	6 (f,q,d, s,o,i)	10 (d,s,z,v,h, b,y,i,f,q)	4
	TE	3 (m,a,r)	10 (m,e,g,k,a, t,p,w,r,j)	7

"straight," vertical line in each space where he was requested to write the letter of the sound he had heard. S-C's posttest paper has horizontal, diagonal, and curved lines in the spaces where letters were to be written.

On Test 2, Emission of Sounds, S-C did not gain in his ability to emit sounds of letters shown to him. The sound "s," (FD), which he emitted correctly during the pretest, was not emitted correctly on the posttest; the sound "d" (FD) was correct on the posttest.

TABLE 5

PRE-POSTTEST DATA: SUBJECT C

Test		Pretest	Posttest	Difference
1. Construction of Letter	Total	0/6	0/13	0
	FD	0	0	0
	TE	0	0	0
2. Emission of Sound	Total	1/14	1/26	0
	FD	1 (s)	1 (d)	0
	TE	0	0	0
3. Multiple Choice	Total	6/13	12/26	0
	FD	4 (s,o,v,n)	7 (d,s,z,v, y,c,q)	3
	TE	2 (k,a)	5 (m,k,l,r,u)	3

The percent of units correct for S-C on the pre- and posttest of Test 3, Multiple Choice, although higher than for any other S on the pretest, must be considered a "chance" performance. It should be noted that some of the letters in both FD and TE pretest results do not appear in the list of letters scored correct on the posttest.

S-D's pre-and posttest data are shown in Table 6. His performance on Test 1, Construction of Letter, was similar to that of S-C. Although his performance gives no evidence of his being able to write a

TABLE 6

PRE-POSTTEST DATA: SUBJECT D

Test		Pretest	Posttest	Difference
1. Construction of Letter	Total	0/13	0	0
	FD	0	0	0
	TE	0	0	0
2. Emission of Sound	Total	0/26	0/26	0
	FD	0	0	0
	TE	0	0	0
3. Multiple Choice	Total	5/13	7/26	-3
	FD	4 (z,o,v,n)	4 (d,v,i,f)	0
	TE	1 (a)	3 (x,l,j)	2

letter after hearing its sound, his ability to form letter shapes improved from making only vertical lines on the pretest to making vertical lines in various positional combinations with a circle on the posttest. His marks are similar to letters we designate as "p," "a," "d," and "q."

On Test 2, Emission of Sound, S-D was unable to make any sounds correctly on either administration. The sounds he emitted on the posttest were the traditional "names" of letters, and even then he could not name a letter correctly.

S-D was the only S who showed a loss from pre- to posttest on any test. On Test 3, Multiple Choice, his adjusted pretest score (10/26) was three units higher than his actual posttest score. It should also be noted that the letters for which S-D received credit on the pretest were, with the exception of one letter, not correct answers on the posttest.

Daily Performance Data

Mean daily response and time data for Ss are shown in Figures 2 through 13. The graphs in those figures show performance data for both the TE and FD methods. Each S has three graphs: the first indicates percentage of correct, first-choice responses; the second represents the mean amount of time each S spent responding to the items; and the third graph shows the mean number of incorrect responses S made on the treatment items.

Figure 2 shows that S-A had a greater percentage of FD than TE items correct, with two exceptions: his FD percentage was 2 per cent and 18 per cent less than his TE percentage for days 12 and 13. S-A's FD percentages were 90 per cent or higher on 6 of the 14 days, with 100 per cent on days two and seven. The lowest FD percentage was 45 on day 12 of the treatment. The highest TE percentage was 83 on the final day of treatment, while the lowest point was on day 10, when S-A got 34 per cent of TE items correct.

An examination of Figure 3, the mean time spent on items, shows a drop in time following the initial day of treatment. The FD time is less

FIGURE 2

PERCENTAGE OF CORRECT, FIRST-CHOICE RESPONSES

Subject A

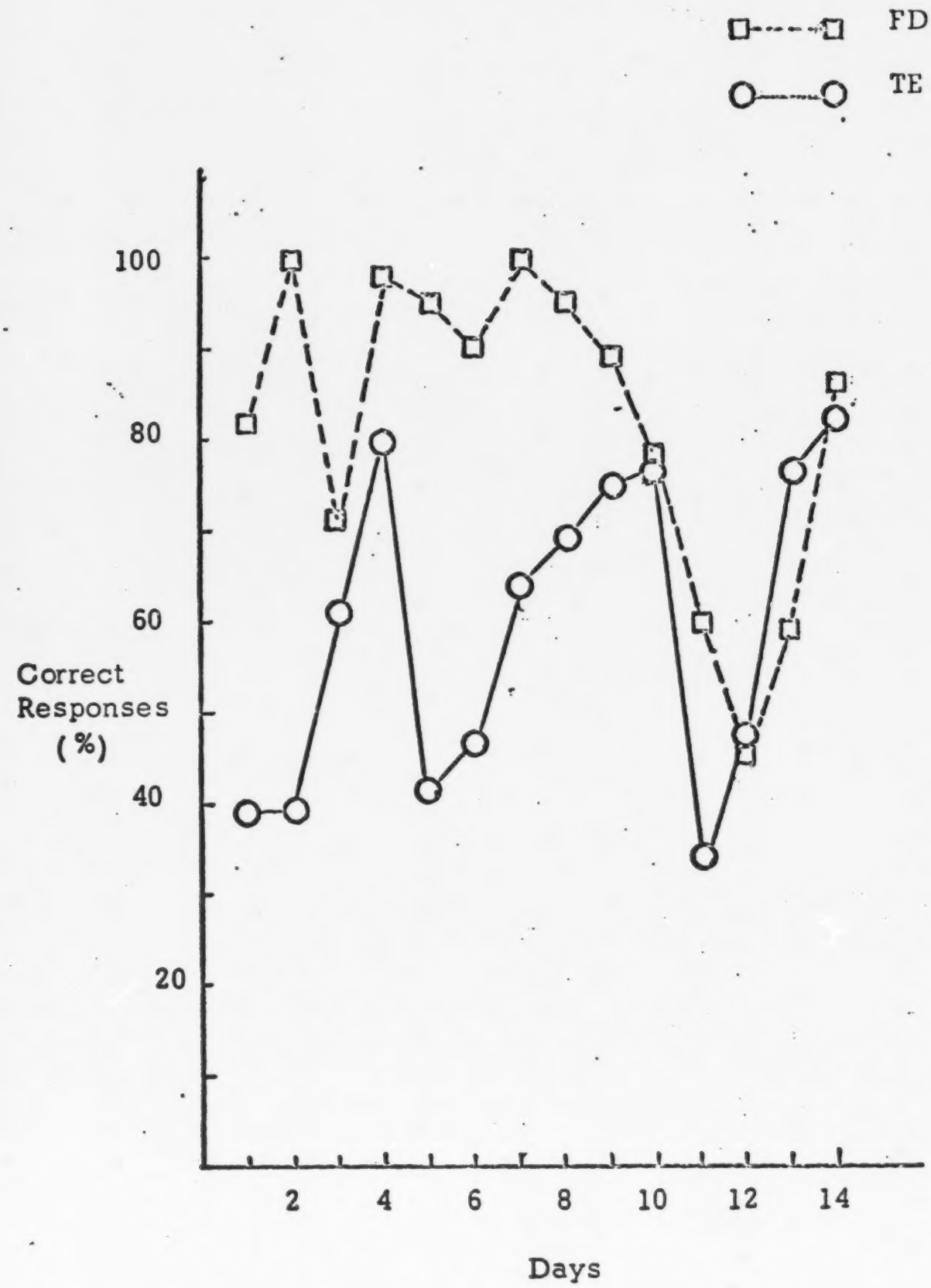
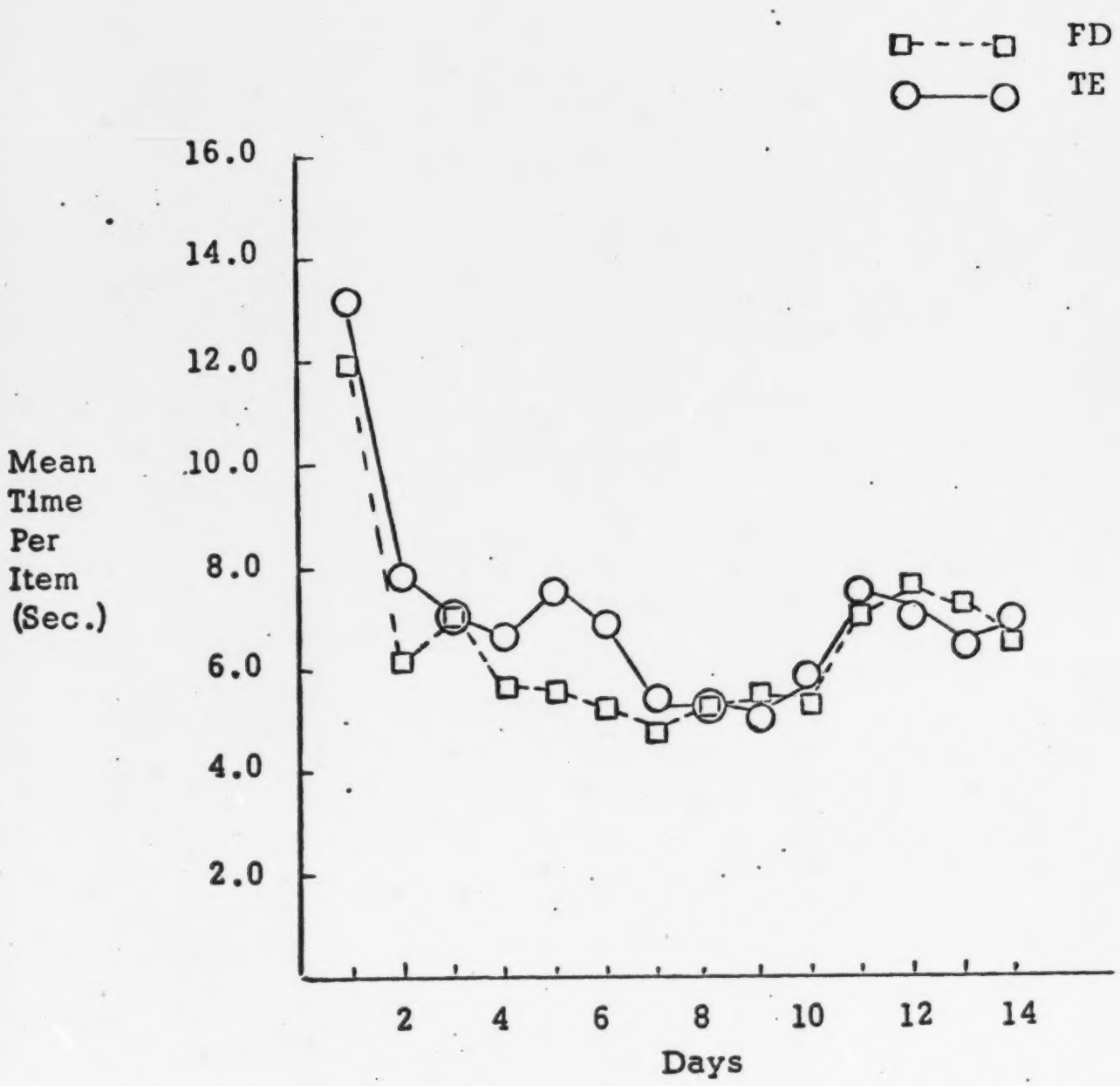


FIGURE 3

MEAN TIME PER ITEM

Subject A



than that of the TE on 9 of the 14 days. The mean time is the same for both methods on days three and eight.

Figure 4 shows that S-A made fewer incorrect choices on FD items for 11 of the 14 days. On days 10 and 13, the same number of incorrect choices was made; and day 11 was the only day on which S-A made more incorrect choices on FD items. The highest number of incorrect choices was made on the TE method on day 11; the lowest number of incorrect choices made was on days two, four, and six, when S-A made zero incorrect choices on the FD items.

Figure 5 shows that S-B had a greater percentage of FD than TE items correct on first choice, except on day three, when his performance on FD items was 2 per cent less than on TE items. S-B's FD percentages were at 90 per cent or higher on 7 of the 14 days. The lowest FD percentage was 75 on the third day of treatment, and the lowest TE percentage was 53 on day one. The highest FD percentage was 100 on day eight; the highest TE percentage was 90 on day four.

An examination of Figure 6, the mean time spent on items, shows a somewhat stable time throughout the treatment period: the mean times for both methods always fell within a 4 to 8 second span. The FD mean time is less than that of the TE on 10 of the 14 days. The least amount of time spent on any treatment day was on day eight for the FD method items. It should be noted that day eight was also the day S-B's percentage of correct, first-choice responses on FD items was 100 (Figure 5).

FIGURE 4

MEAN NUMBER OF INCORRECT RESPONSES

Subject A

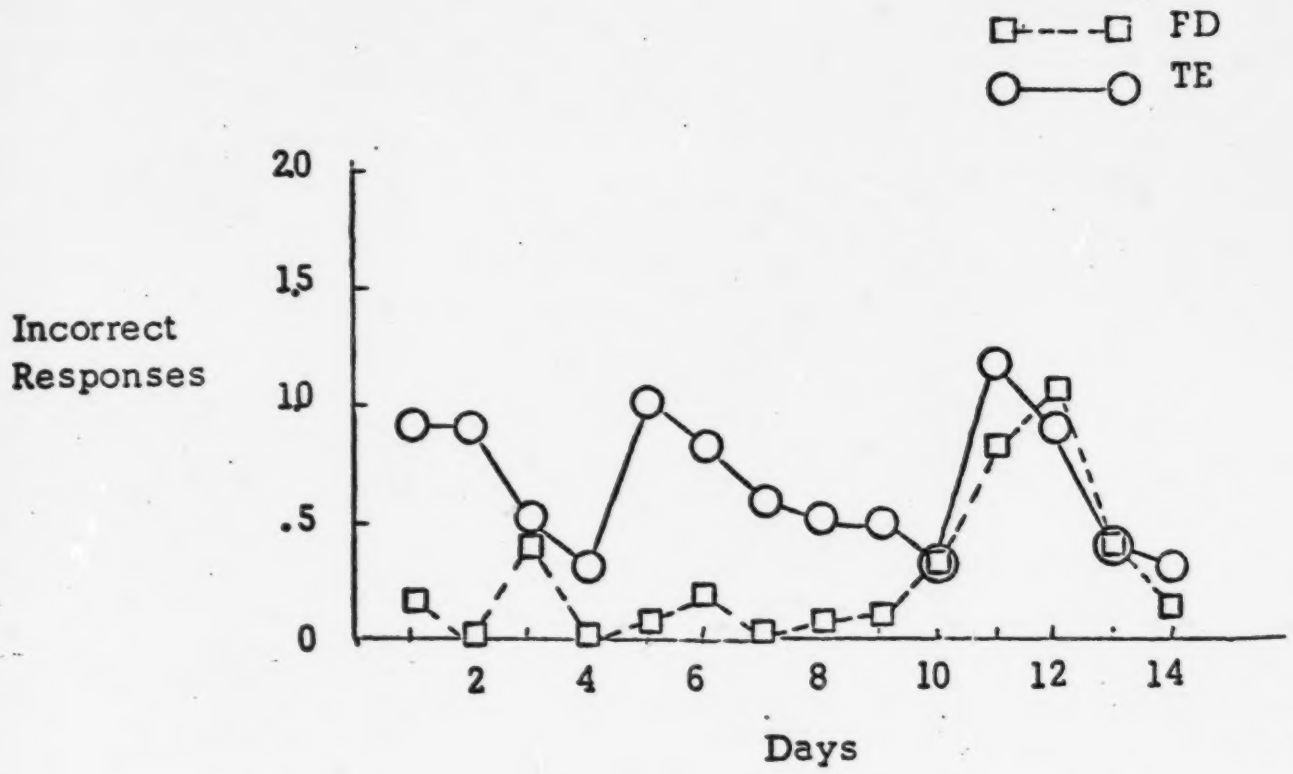


FIGURE 5

PERCENTAGE OF CORRECT, FIRST-CHOICE RESPONSES

Subject B

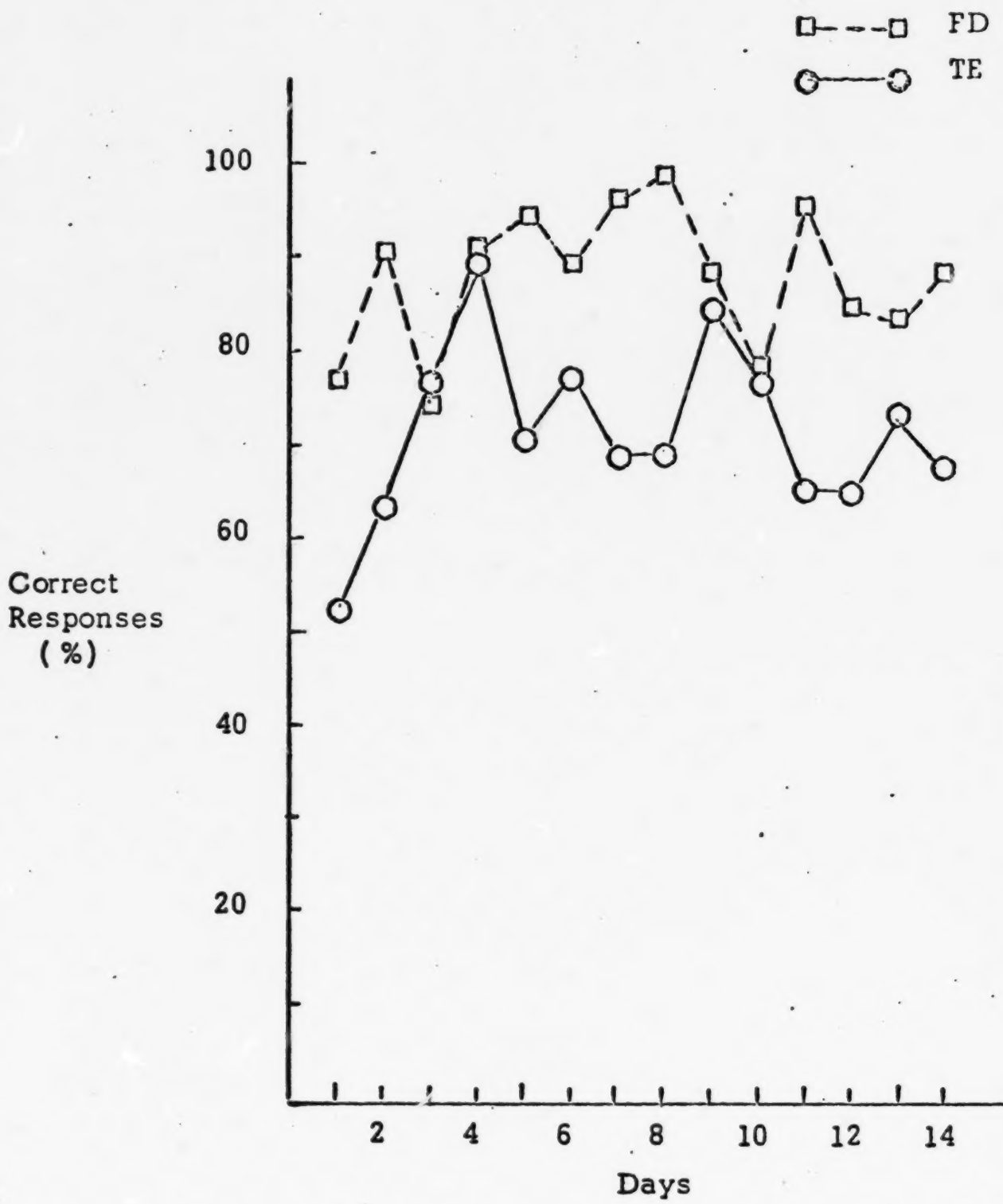


FIGURE 6

MEAN TIME PER ITEM

Subject B

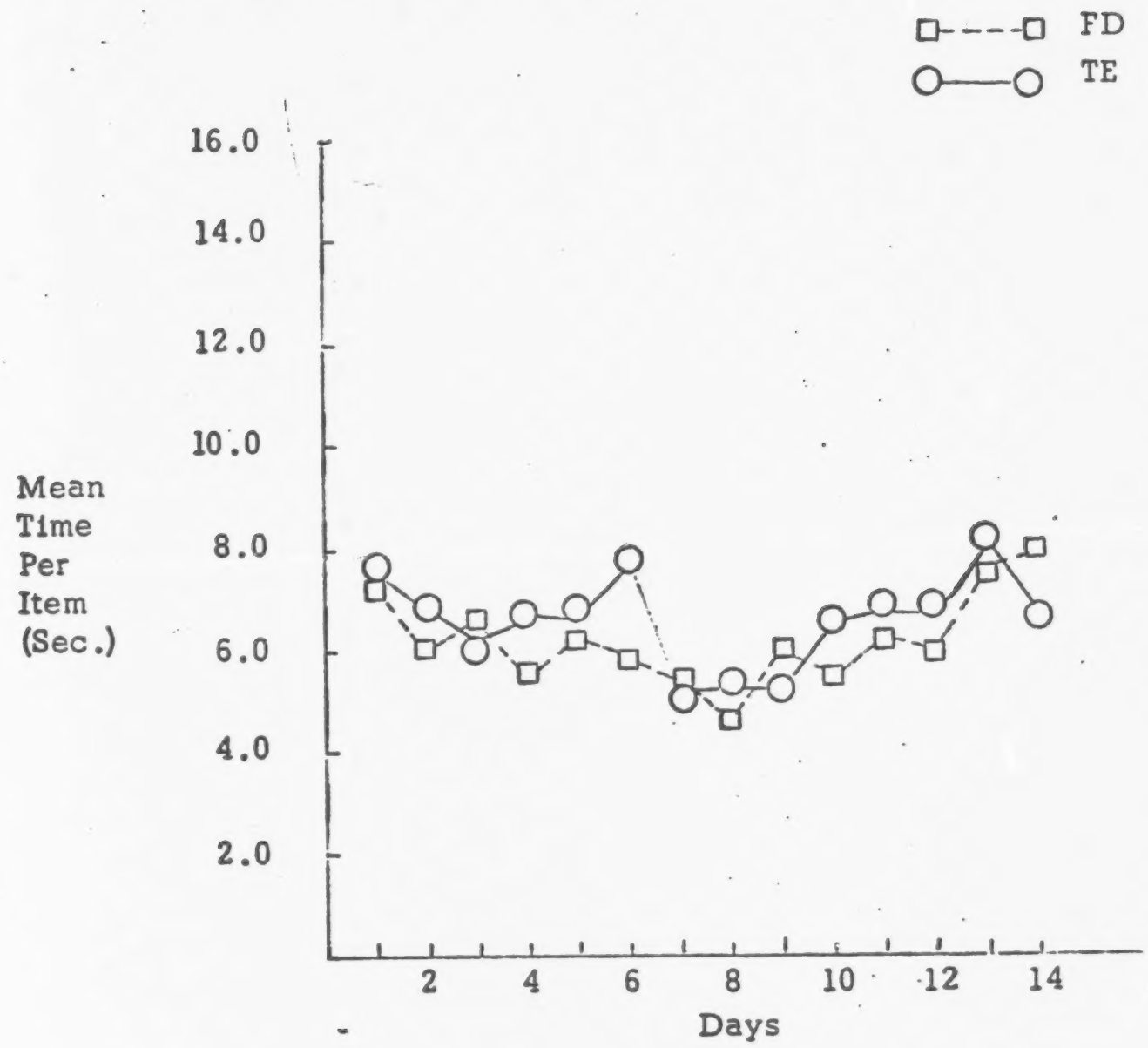


Figure 7 shows that S-B's mean number of incorrect choices made per item was less for FD method on 11 of the 14 treatment days. On days 4 and 10, the same number of incorrect choices was made for both methods. The highest number of incorrect choices made was on the TE method on day one; the lowest number of incorrect choices made was on days seven and eight, when S-B made zero incorrect choices on the FD items.

Figure 8 shows that S-C had a greater percentage of FD that TE items correct on first choice, except for day three, when his performance on FD items was 23 per cent as compared to 38 per cent TE. S-C's FD percentages were 80 per cent or higher on 10 of the 14 treatment days. Highest FD percentages were on days seven and eight, when S-C got 98 per cent of the items correct on first choice; highest TE percentage was 54 on day four. All TE percentages range between 24 and 54 per cent.

An examination of Figure 9, the mean time spent on items, shows that S-C spent the same amount of time responding to FD and TE items on days two and three. Due to mechanical failure, there was no time data recorded for days one and four. On days five through 14, FD time is consistently less than TE time. The least amount of time spent on any treatment day was on day eight for the FD method items.

Figure 10 shows that S-C's mean number of incorrect choices made per item was less for the FD method on 13 or the 14 treatment days. The highest number of incorrect choices was made on day three, and the lowest number of incorrect choices was made on day 10, both on FD items.

FIGURE 7

MEAN NUMBER OF INCORRECT RESPONSES

Subject B

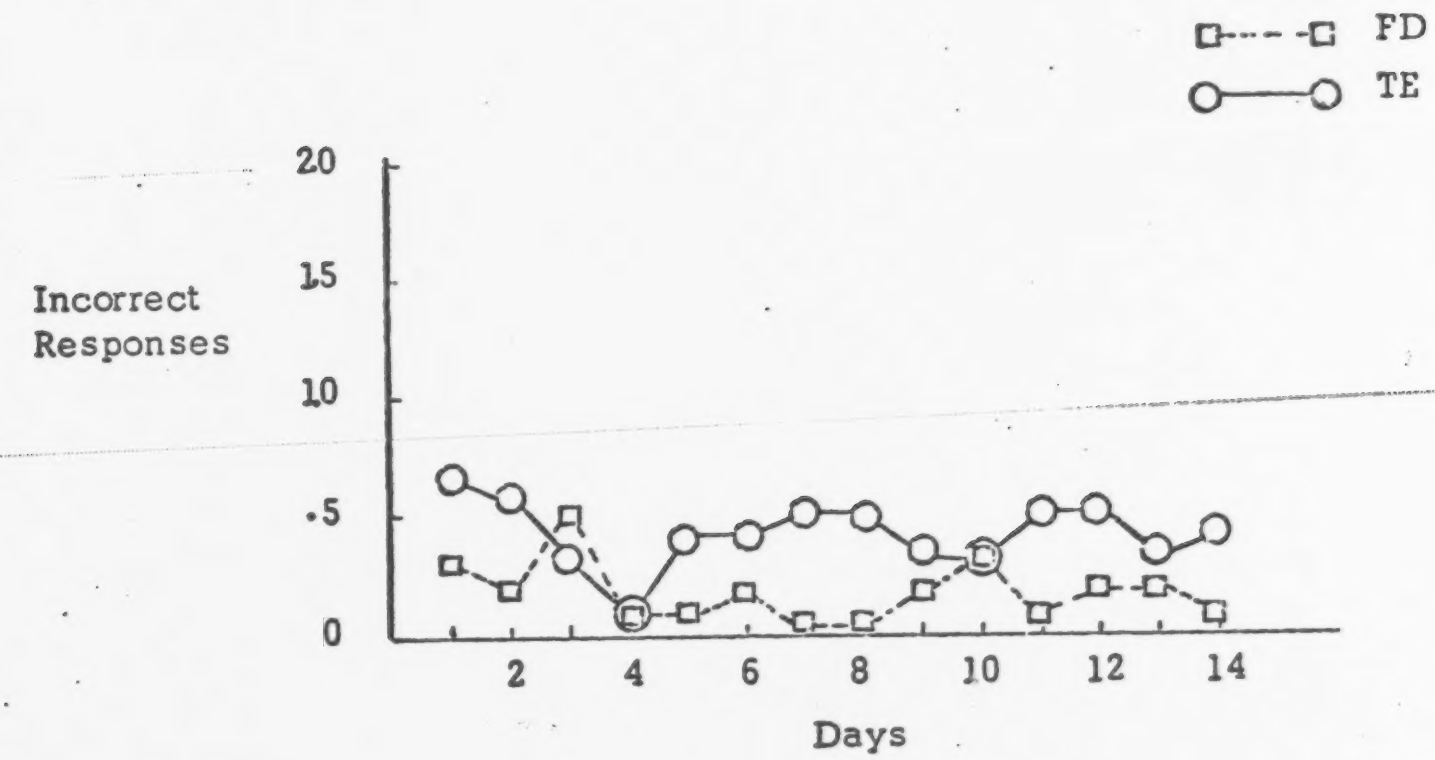


FIGURE 8

PERCENTAGE OF CORRECT, FIRST-CHOICE RESPONSES

Subject C

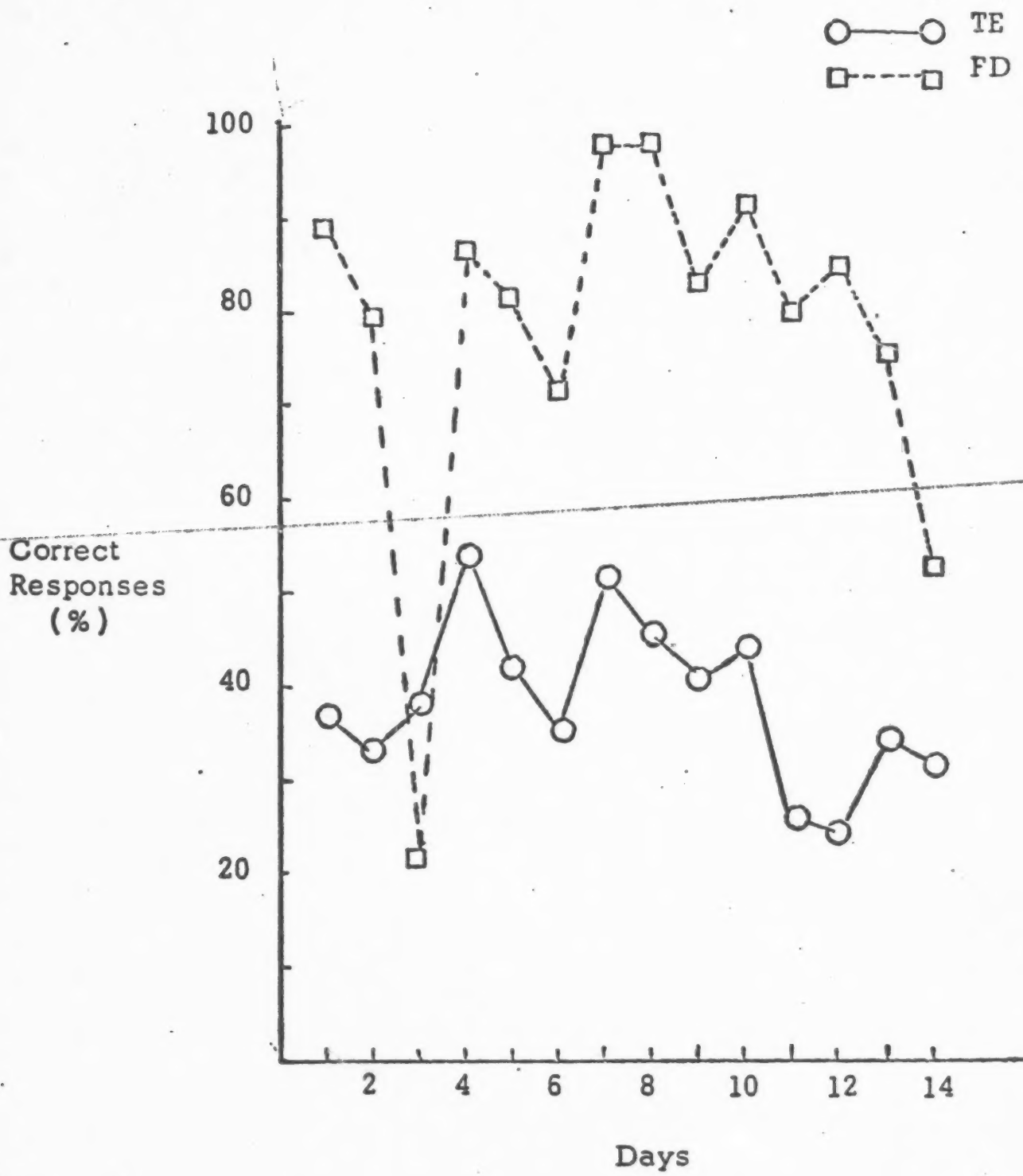


FIGURE 9

MEAN TIME PER ITEM

Subject C

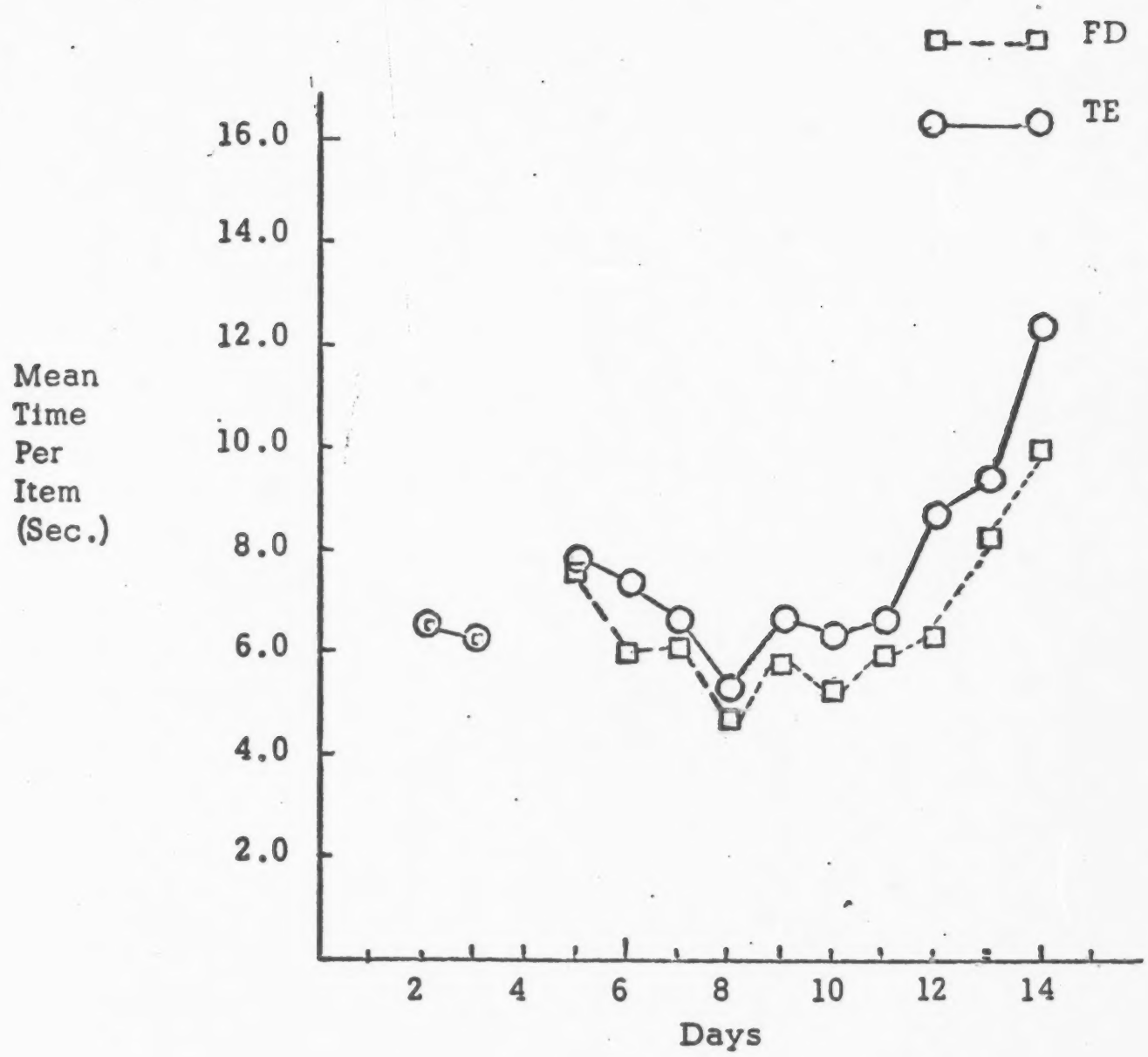


FIGURE 10

MEAN NUMBER OF INCORRECT RESPONSES

Subject C

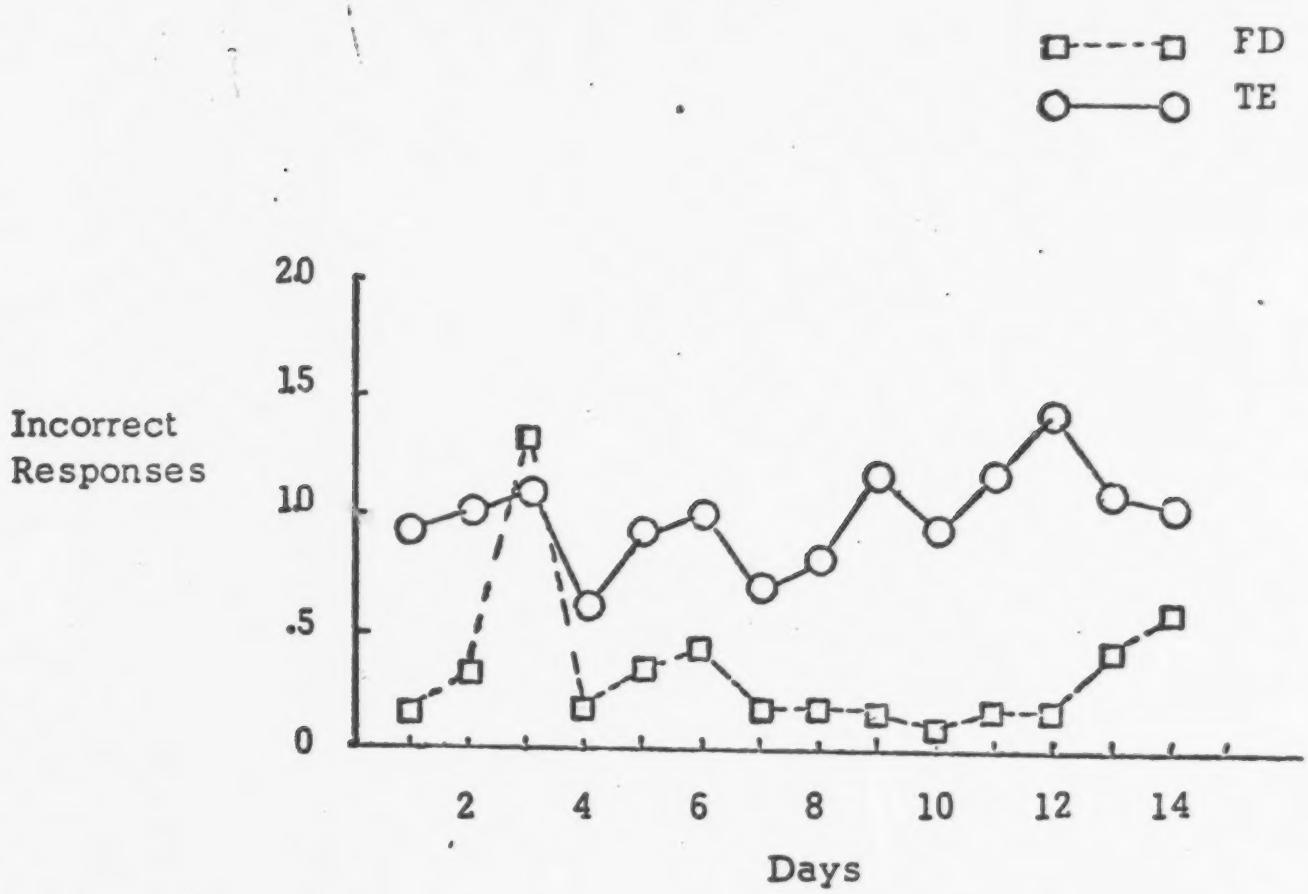


Figure 11 shows that S-D had a greater percentage of FD than TE items correct on first choice for 9 of the 11 days. His highest percentage of correct responses was on day seven, when he had 94 per cent of FD items correct on first choice; his lowest percentage correct was 28, TE items, on day two.

An examination of Figure 12, the mean time spent on items, shows that S-D took less time to complete FD items than TE items on 9 of the 11 treatment days. The greatest amount of time spent was on day one, for FD items. The least amount of time spent was on day 10, when S-D responded to FD items at a mean of 6 seconds per item.

Figure 13 shows that S-D's mean number of incorrect choices made per item was less for the FD method on 8 or the 11 treatment days. The highest number of incorrect choices was made on day 11 on TE items; the lowest number of incorrect choices was made on day seven on FD method items.

FIGURE 11

PERCENTAGE OF CORRECT, FIRST-CHOICE RESPONSES

Subject D

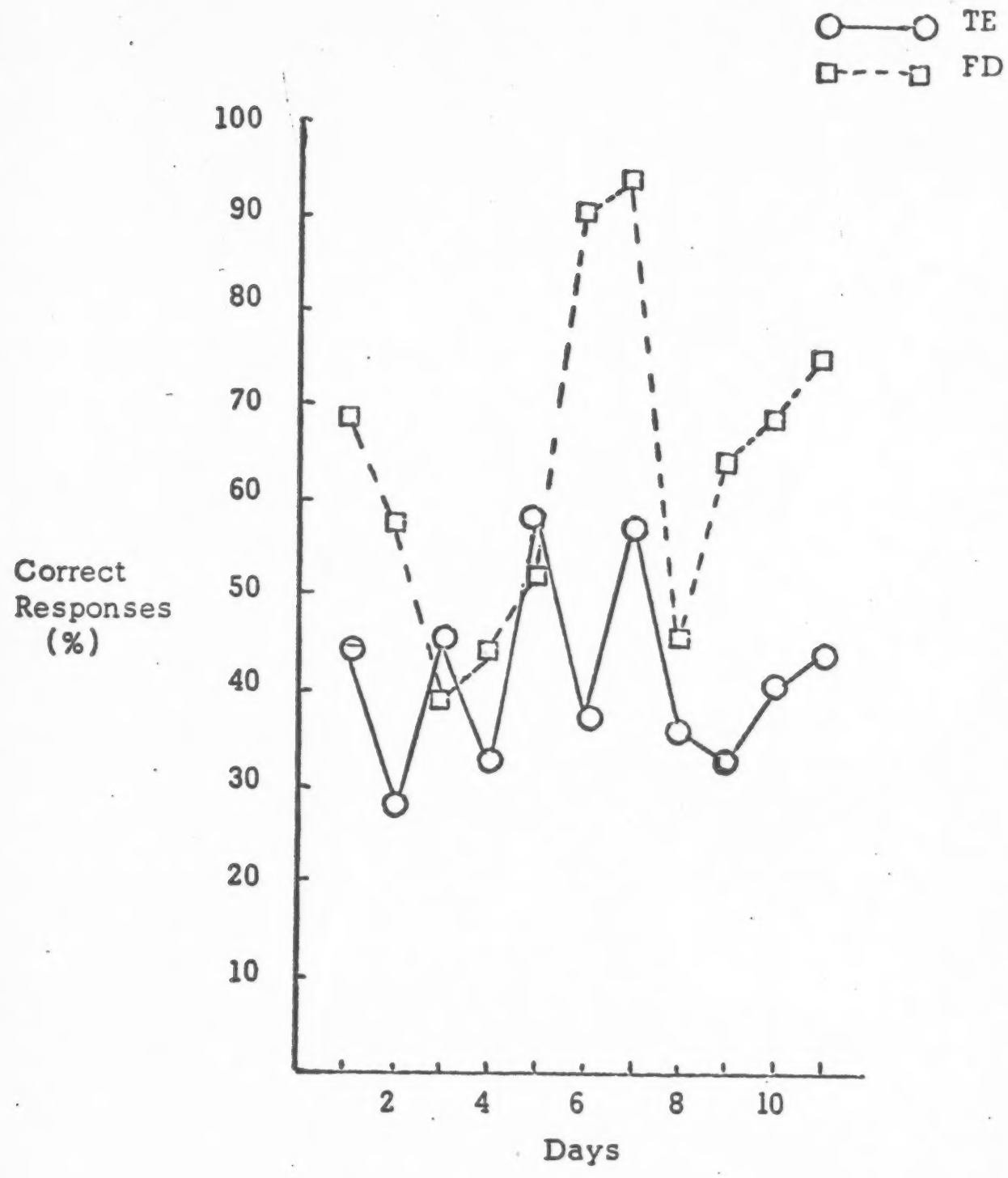


FIGURE 12

MEAN TIME PER ITEM

Subject D

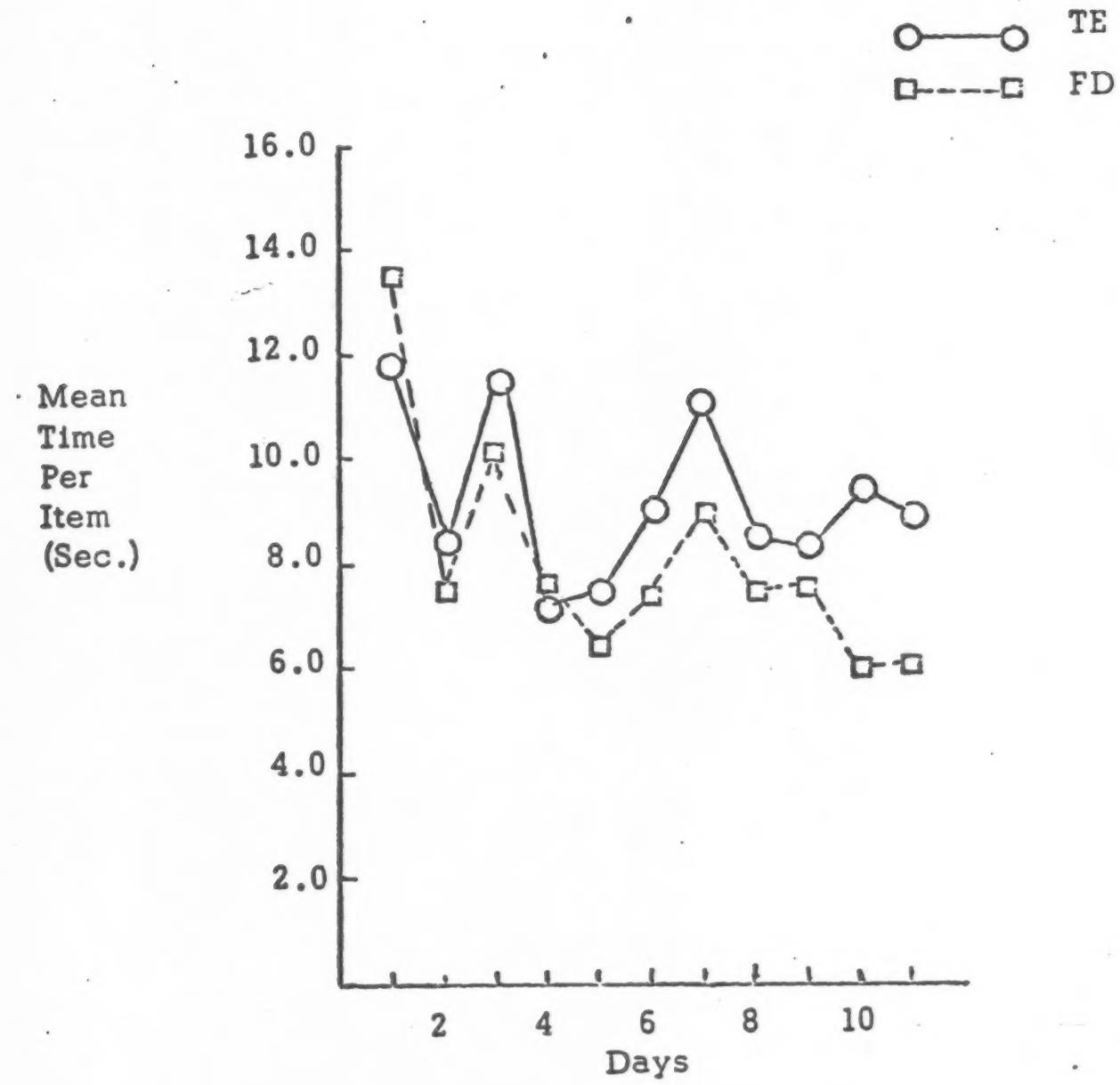
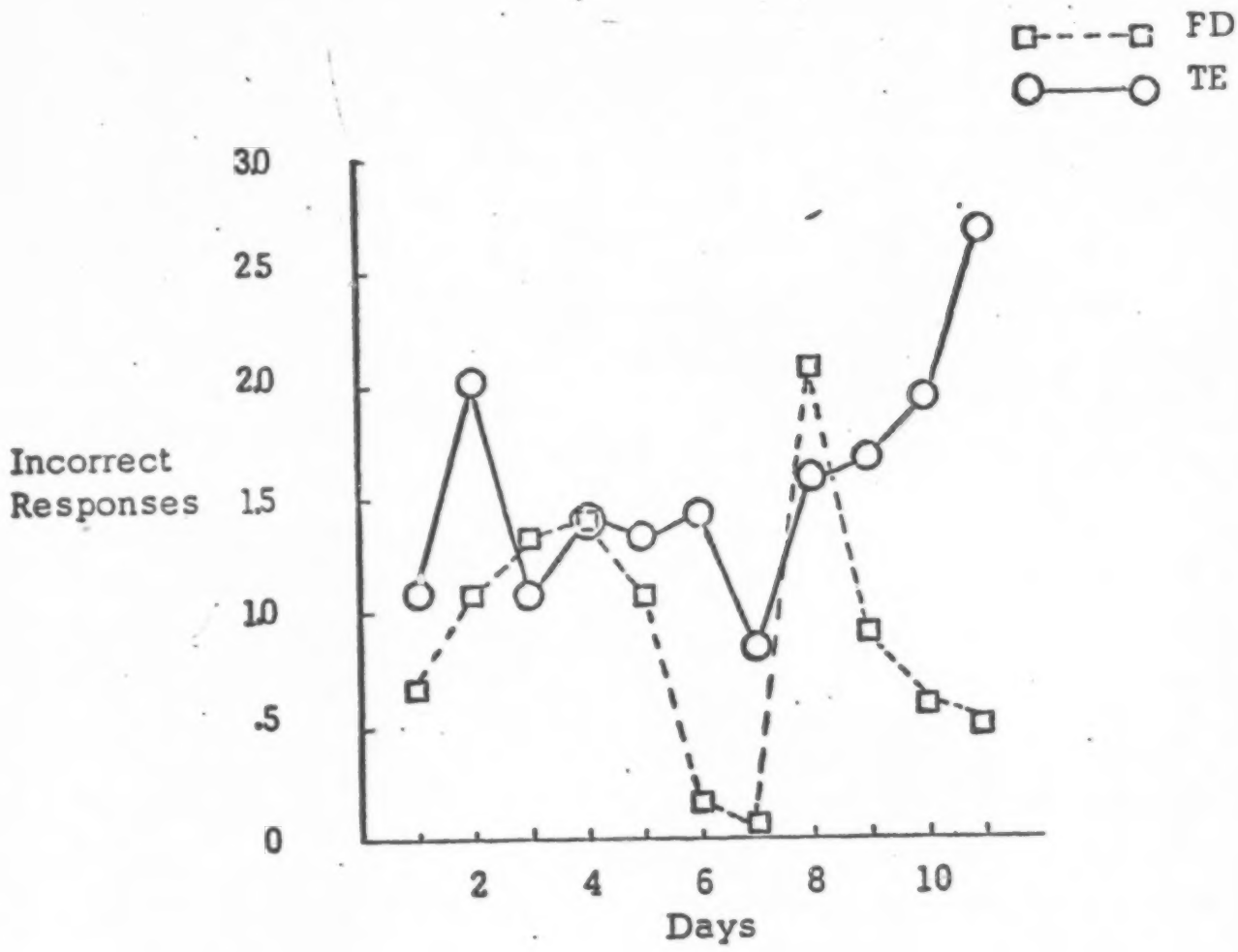


FIGURE 13

MEAN NUMBER OF INCORRECT RESPONSES

Subject D



CHAPTER VI

DISCUSSION

Subject Behavior

S-A seemed to enjoy taking part in the study. When he arrived, he walked to the reinforcer display, examined the new items, and, a few minutes later, announced the toy or candy item he wished to earn that day.

After he entered the experimental room, he worked quickly and was attentive to his task. When he got a token, he sometimes cheered and shook his hands in the air, and at other times simply talked agreeably to himself. A particularly important aspect of his verbal behavior was his tendency to correctly emit the sound of a letter as an item appeared in the windows of the teaching machine. S-A was frequently able to emit the FD sound before it was given by the tape player. This verbal behavior may have affected his ability to correctly emit sounds on the Test 2 posttest measure. His gain from pre- to posttest was from zero to five units correct. No other S verbalized the sounds, and no S made as large a gain.

S-A's "model" behavior abruptly ceased on day 11, when he began intentionally pushing incorrect windows. He suddenly seemed to have a negative attitude towards the tasks. Perhaps something in

school had disturbed him, or he may have become tired of the treatment; however, there had been no previous indication of his irritation with the tasks, so the latter explanation is questionable. Figures 2 through 4 show how this change in behavior affected his performance graphs: he had a lower percentage of correct responses, took more time to complete the program, and made more errors in responding. S-A recovered from his "negativism" by day 14, the final day of treatment.

During the first treatment periods, S-A chose money and candy reinforcers with equal frequency. Later he chose a yoyo, a whistle, 5 cent candy bars, milk duds, a compass, marbles, and a notebook.

S-A's pre- and posttest data show that he learned letters from both methods about equally well (Table 3). The only clear-cut differential in the two methods was shown on Test 2, Emission of Sound, when S-A gained four FD letters to one TE. As was discussed, S-A often emitted the correct sound of a letter shown as soon as an item appeared in the response windows of the teaching machine, and his sound was frequently emitted before the tape player gave the correct sound. The differential in the two methods on Test 2 may be accounted for by the fact that on TE items, he could have chosen any one of three sounds to emit, not knowing which one would be correct until the tape player gave one; however, on FD items, only one sound was ever appropriate, thus making it easier for S-A to emit FD sounds.

S-A's daily performance graphs (Figures 2 through 4) show that he almost always had a higher percentage of correct responses, worked faster, and made fewer incorrect choices on the FD method.

S-B also seemed to enjoy the training periods; however, he was more serious than S-A toward the tasks. After a quick look at the reinforcers, S-B was anxious to begin. He worked quickly, with a rhythmical response pattern and was attentive to his task. When he pushed the correct window first, he glanced over to see that the token fell, and went back to work, usually without changing his facial expression. Perhaps S-B's seriousness was related to the fact that he is older than the other Ss and has been frustrated in school in learning letter sounds and in reading.

During the first few days of performance, S-B exhibited a type of "superstitious" behavior; he began touching his finger to his mouth before pushing a window. This behavior was not evident later in the treatment. S-B bit his nails and breathed quite heavily at different periods during the training program. The heavy breathing or panting was not a result of failure or success on the program, for it seemed to occur at random times each day, not necessarily when S-B was in the experimental room. E was concerned about this behavior, and learned that it occurs frequently in the classroom too.

At first, S-B chose money and occasionally candy as reinforcers. The only toy he chose was a pair of sun glasses. E noticed that S-B was not really interested in the reinforcers available to him, and that

he enjoyed watching the white laboratory rats which were caged in another part of the room. After day 7, S-B was allowed to earn the privilege of holding one particular rat he liked for a specified length of time; later he earned the rat as a pet.

S-B's pre- and posttest data show that he learned letters from both methods, with a tendency to learn more TE letters than FD letters (Table 4). The slight differential might be related to a history of performing on TE type materials (Touchette, 1968). S-B's daily performance graphs (Figures 5 through 7) show that he almost always had a higher percentage of correct responses, worked faster, and made fewer incorrect choices on the FD method.

S-C's behavior might best be described as inconsistent. On some days he was eager to come to the laboratory, and on other days he tried to delay his arrival. Once there he usually enjoyed looking at the reinforcers, but was not often ready to begin the work. His attention to the task was sporadic; at times S-C scrutinized the letter choices, occasionally tracing the shapes lightly with his finger before pushing a window; and at other times, he pushed windows without looking at the choices or according to an order pattern of left to right or right to left progression.

S-C did not like to be alone in the experimental room; he would not begin the program unless the door was left partly open. He whined and pounted when he did not get enough tokens to "buy" a certain reinforcement item he desired. S-C chose penny candy, candy bars, airplanes, a candy

rabbit, play dough clay, play money, and a parachutist toy as reinforcers.

S-C's pre- and posttest data do not indicate a gain of letters from either method. As was discussed previously (Results), S-C did improve in his ability to express his concept of formation of letters as shown by his more sophisticated "letter" markings on his posttest performance of Test 1.

S-C's inconsistent behavior was apparent on his posttest results from Test 2, Emission of Sound (Table 5); he failed to emit the sound "s" correctly which he had successfully done on the pretest. In addition, several of the letters S-C chose correctly on the Test 3 pretest, Multiple Choice, were not correct on the posttest. This may suggest that his pretest performance on Test 3 was "guessing" behavior.

Although S-C did not learn letter sounds, his daily performance data (Figures 8 through 10) show that he generally had a higher percentage of correct responses, worked faster, and made fewer incorrect choices on the FD method. On the last day of treatment, S-C complained that he felt sick. He whined and became so upset that he was able to complete very few items within a minute's time. E terminated the period after unsuccessfully encouraging S-C to finish. The effects this poor performance had on his daily graphs can be seen on Figures 8 through 10.

Although S-D was reportedly eager to come to the laboratory, he was the most difficult subject with which to work: he was boisterous and demanding of attention upon arrival, was not interested in the available reinforcers, disliked beginning the task, and exhibited much

inattentive and guessing behavior during the treatment program. While in the experimental room, he pushed two windows simultaneously, pounded the same window repeatedly after learning that it was incorrect, traced around the machine and response windows with his fingers, grumbled, and pouted. Many of his responses were made while he looked away from the machine.

There may be at least four possible explanations for S-D's behavior. He may have been frustrated by the level of difficulty of the tasks; however, this is unlikely since he never seemed to try earnestly to respond correctly, and when E sat near S-D, he did try and frequently responded correctly. Another possible explanation is that S-D was not concerned about the consequences of his performance: S-D was not interested in the available reinforcers. This was evident by S-D's greatly improved performance on the day he wanted a toy ring; during that performance S-D even attempted to stack and count his tokens to see if he was going to earn enough. A third explanation is that S-D was being reinforced by all of the attention and annoyance reaction he aroused in E. His perception of E's considerable attempts to identify what he liked may have made him feel somewhat in control of the situation. Perhaps S-D did not have sufficient attention behavior to focus on the relevant stimuli in the situation. These four possibilities may each have contributed to S-D's behavior.

Because of S-D's poor daily performance at the beginning levels of discrimination, it was considered pointless to continue into more difficult parts of the treatment program as was planned and being done with the other Ss. S-D's program, which was modified following day four

included: Part 1, days one and two; Part 2, days three and four; Part 1, days five, six, and seven; and Part 2, days 8 through 11. It is encouraging to note that S-D's percentage of correct responses increased with repetitions of a Part (Figure 11).

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to determine the effectiveness of errorless form discrimination training in teaching young retarded children to pair a given letter symbol with a specific sound. The effectiveness of the errorless discrimination training was determined by comparing it with the customary trial-and-error discrimination technique which makes no provision for minimizing errors. A secondary objective of the study was to determine the extent to which the letter-sound discriminations would generalize to the skill areas of emission and construction of a letter when the appropriate cue was presented.

Subjects were four mentally retarded males in primary and intermediate special school programs who were chosen because of their lack of knowledge of the sounds of letters. Ss performed daily on teaching machines for 15 minutes of 14 consecutive school days. Each S was alternately exposed to each training method on all treatment days. Each method provided discrimination training of letter sounds and symbols for 13 of the 26 letters in the alphabet.

Data obtained from pre- and posttests were presented in table form and were interpreted in terms of gains of correct sound-symbol

associations. Daily performance data were presented as three graphs for each subject. The graphs include: information for both methods concerning: percentage of correct, first-choice responses; the mean amount of time spent responding to the items; and the mean number of incorrect responses made on the items.

Conclusions

Errorless form discrimination training in teaching young retarded children to pair a given letter symbol with a specific sound was found as effective as customary trial-and-error discrimination training in producing gains. However, the errorless method differed in respect to daily performance, for it generally resulted in a higher percentage of correct responses made in less time than did the trial-and-error method. The letter-sound associations which were mastered did not often generalize to related verbal skills.

Implications

There was evidence to support the conclusion that the performance of the four children involved in this study was more efficient on the errorless form discrimination technique than on the trial-and-error technique. However, further research and refinements are needed to determine: (1) if the above conclusion is applicable to larger numbers of children, and (2) if the technique is more effective than customary discrimination training in teaching retarded children to pair a given letter symbol with a specified sound.

Suggestions for Further Research

One of the greatest weaknesses of this study was the way in which items from the two discrimination methods were alternated, allowing the effects of performance on one to interact with the effects of the other. For example, if the child made the correct discriminations on the entire block of three form discrimination items, he experienced success. Following this suppose he was subjected to three trial-and-error items, on which he was unable to make the correct discriminations, and experienced failure. He had just experienced success and the accompanying reward and was about to have more form discrimination items on which he could be successful. Previous and anticipated success on one method might soften failure experienced on the other. In addition, success or failure on one method might affect S so that he did or did not try harder on the subsequent technique. Interaction of the two methods may have greatly influenced daily performance to an unknown degree. Some control for this interaction should be provided in future research.

Although much research has been done concerning what reinforcers are effective with retarded children, it still remains an individual matter as to what is reinforcing to a particular child. It was incorrectly assumed in this study that at least some of the items made available would be reinforcing for each child. Future research of this type should consider a longer pre-treatment investigation of the things each child finds reinforcing.

Ss in this study were on a continuous reinforcement (CRF) schedule: for every first-choice correct response, they received a token. It seemed essential to use CRF in order to inform S when he was right; however CRF leads to satiation and rapid extinction. Future research should attempt to identify some method of using a different schedule of reinforcement while continuing to provide immediate knowledge of results. An additional weakness concerning the reinforcement procedure used in this study is that the child had to delay his exchange of tokens for reinforcers until he had completed the entire daily treatment program. Ideally, the reinforcement schedule and delay of actual reinforcement should be flexible to allow for differences in individual children.

A differential influence which may have detracted from gains for the form discrimination (FD) method is that S could make a correct visual discrimination of the FD items without attending to the auditory cue. This was not a factor on the multiple choice items of the trial-and-error method, where three different letters were presented and it was necessary for S to listen to the cue in order to make the correct response. If S did not listen to the auditory cues on the FD method, he could not easily form the desired sound-symbol associations. Future research should make some modifications so that Ss are required to listen to the relevant sounds in order to respond correctly.

This study employed no control for level of phoneme confusion, a factor which may have had a detracting differential influence on success

and gains on the trial-and-error method. The sound "p" may have been the auditory cue for the multiple choice item showing "t," "p," and "k" as possible choices. Auditory discrimination among the sounds these three letters make is classified as a level of fine discrimination. It would be advisable to take this variable of level of phoneme confusion into account when planning a treatment program such as the one in this study.

Well-controlled studies with individuals as well as with groups of children will be necessary to establish the effectiveness of errorless form discrimination training in teaching retarded children to make sound-symbol associations. If such training is found effective, it will have great implications for an individualized sensory stimulation approach to teaching retarded children to read.

BIBLIOGRAPHY

Bijou, S. W., Birnbrauer, J. S., Kidder, J. D., & Tague, C. Programmed instruction as an approach to teaching of reading, writing, and arithmetic to retarded children. The Psychological Record, 1966, 16, 505-522.

Brown, R. I. A remedial reading program for the adolescent illiterate. Journal of Special Education, 1967, 1, 409-417.

Evans, J. L. Multiple-choice discrimination programming. Paper read at American Psychological Association Convention, New York, September, 1961.

Goldstein, H. & Levitt, E. Reading readiness workbooks. Parkinson Program for Special Children, Follett, 1968.

Gollin, E. & Savoy, P. Fading procedures and conditional discrimination in children. Journal of the Experimental Analysis of Behavior, 1968, 11, 443-451.

Johnson, G. F. Programmed instruction and the exceptional learner. Exceptional Children, 1968, 34, 453-457.

Kirk, S. A. & Johnson, G. O. Educating the retarded child. Cambridge: Houghton Mifflin, 1951.

Malpaas, L. F. Programmed instruction for retarded children. In A. A. Baumeister (Ed.), Mental retardation. Chicago: Aldine Press, 1967. Pp. 212-231.

McCarthy, J. J. & Scheerenberger, R. C. A decade of research on the education of the mentally retarded. Mental Retardation Abstracts, 1966, 3, 481-501.

McCarthy, W. & Oliver, J. Some tactile-kinesthetic procedures for teaching reading to slow learning children. Exceptional Children, 1965, 31, 419-421.

Moore, R. & Goldiamond, I. Errorless establishment of visual discrimination using fading procedures. Journal of the Experimental Analysis of Behavior, 1964, 7, 269-272.

Sheperd, G. Selected factors in the reading ability of educable mentally retarded boys. American Journal of Mental Deficiency, 1967, 71, 563-570.

Sidman, M. & Stoddard, L. T. The effectiveness of fading in programming a simultaneous form discrimination for retarded children. Journal of the Experimental Analysis of Behavior, 1967, 10, 3-15.

Silberman, H. F. Reading and related verbal learning. In R. Glaser (Ed.), Teaching machines and programmed learning, II. Washington, D.C.: National Education Association of the United States, 1965. Pp. 508-545.

Smith, R. M. Clinical teaching: Methods of instruction for the retarded. New York: McGraw-Hill, 1968.

Strang, P. Step by step instruction in beginning reading for slow learners. Exceptional Children, 1965, 32, 31-36.

Terrace, H. S. Discrimination learning with and without 'errors.' (1963) rev. In Ferster & Perrott (Eds.), Behavior principles. New York: Appleton-Century-Crofts, 1968, Pp. 468-476.

Touchette, P. E. The effects of graduated stimulus change on the acquisition of a simple discrimination in severely retarded boys. Journal of the Experimental Analysis of Behavior, 1968, 11, 39-48.

Watson, L. S. & Lawson, R. Instrumental learning in mental retardates. Mental Retardation Abstracts, 1966, 3, 1-20.

Williams, P. Initial testing alphabet (ITA)-Interim assessment. Winnower, 1965, 1 (2), 27-44.